Henry Ford Bridge (Badger Avenue Bridge)
Spanning Cerritos Channel
Los Angeles and Long Beach Harbor
Los Angeles County
California

HAER No. CA-156

HAER
CAL
19-LOSAN,
75-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, California 94107

HAER
CAL
19-LOSAN,
15-

HISTORIC AMERICAN ENGINEERING RECORD
HENRY FORD BRIDGE (BADGER AVENUE BRIDGE)
HAER NO. CA-156

Location:	City of Long Beach, railroad bridge spanning Cerritos Channel 4.8 miles upstream of the Los Angeles and Long Beach Harbor entrance Los Angeles County, California U.S.G.S. 7.5 minute Long Beach, California, quadrangle UTM Coordinates: 11 385000.3736600
Date of Construction:	1923-1924. Altered 1948, 1952, 1957, 1978, 1979, 1994
Engineer:	Joseph Baermann Strauss
Builder:	Ross Construction Company, Los Angeles, California
Present Owner:	Los Angeles Harbor Department 425 South Palos Verdes Street P.O. Box 151 San Pedro, CA 90733-0151
Present Use:	Railroad bridge To be demolished 1994
Significance:	The Henry Ford Bridge (Badger Avenue Bridge) is one of only two surviving Strauss double-leaf bascule railroad bridges in North America. It was an important transportation link in the Los Angeles-Long Beach Harbor, which in 1923 was beginning its growth into one of the world's key port facilities. The designer of the bridge, Joseph Strauss, was also the designer of the Golden Gate Bridge in San Francisco, California.

Report Prepared by:	Jerry Hittleman Senior Environmental Planner P&D Environmental Services 401 West A Street, Suite 2500 San Diego, CA 92101	Larry Smith, Jr. Environmental Scientist Los Angeles Harbor Department 425 S. Palos Verdes Street P.O. Box 151 San Pedro, CA 90733-0151

Date:	January 1995

I. DESCRIPTION

The Henry Ford Bridge (Badger Avenue Bridge), hereafter referred to as the Ford Bridge, is a Strauss, heel trunnion, double-leaf steel truss bascule railroad bridge spanning Cerritos Channel, connecting Wilmington and Terminal Island approximately 4.8 miles upstream of the main Los Angles/Long Beach Harbor entrance. The Ford Bridge is the only railroad link to Terminal Island. Therefore, it serves the Ports of Los Angeles and Long Beach, the Long Beach Naval Shipyard, the U.S. Naval Station, and private businesses.

The total length of the bridge is 760 feet, consisting of two center movable bascule leaves each 110 feet long, two 50 foot tower spans, and two timber trestle approaches each approximately 220 feet long. The cross-section width of the bridge is 70 feet, the horizontal clearance for navigation is 180 feet between fenders, and the vertical clearance for navigation is nine feet above Mean High Water in the closed position, and unlimited when open (U.S. Department of Transportation, 1990).

The present bridge structure reflects modifications made to the bridge since it was constructed in 1924 at a cost of $980,000. The bridge's supporting floor system originally included longitudinal girders to carry two railroad tracks, two highway lanes, and pedestrian traffic. Presently, the Ford Bridge carries one rail line for railroad traffic and a maintenance road which is used by the bridge operator and other workers. The bridge was closed to vehicular and pedestrian traffic in 1978, due to safety concerns.

Due to subsidence in the Wilmington area, caused by pumping of petroleum from underground reserves, it has been necessary to raise the bridge foundations and superstructure twice. In 1948, the bridge was raised seven feet, and another seven feet in 1957. Since 1957, oil companies have injected water into the underground geologic strata, and subsidence has ceased. In 1952, the bridge was damaged as the result of a ship collision. Emergency repairs were made to the bridge at that time.

In 1979, the timber railroad trestles were renovated, and a portion of the roadway trestles restored to provide additional lateral strength and stability to the railroad section. Subsequently, the railroad approach trestles were strengthened, partially demolishing the deteriorated highway approaches and removing the deteriorating fender system.

II. ENGINEERING INFORMATION

Original Bridge Structure

The Ford Bridge was designed by Joseph Baermann Strauss, founder of the Strauss Bascule Bridge Company, whose life work culminated in the design of the 4,000-foot Golden Gate Suspension bridge in San Francisco Bay. The Los Angeles Board of Harbor Commissioners let the contract for the Ford Bridge in October of 1922. Work was completed in fiscal year 1923-1924 at a cost of $980,000 as reported in the 1924 Annual Report of the Los Angeles Board of Harbor Commissioners (refer to photograph 56 and Field Record photographs). The Report called the structure the largest and heaviest of its kind ever built, "similar bridges having a longer span, none having the same width for an equal length." The metalwork was fabricated by the American Bridge Company, Ambridge, Pennsylvania, and erected by the Ross Construction

Company, Los Angeles, California. It is an example of a Strauss, heel-trunnion, double-leaf railroad bascule bridge. Unique features of this bridge, are that it has three lines of trusses, and (as originally designed) provided both railroad and highway service to Terminal Island. Photocopies of the original engineering drawings are attached as photographs 57-94. A copy of the original U.S. Army Corps of Engineers permit for construction of the Ford Bridge is attached to this report.

The double-leaf steel truss bascule spans 760 feet across Cerritos Channel, with two center leaves of 110 feet each, one 50 foot tower span at each end, and two timber trestle approaches, each approximately 220 feet long. The cross section width is 70 feet. Horizontal clearance for navigation is 180 feet between fenders; vertical clearance for navigation is 9 feet above Mean High Water in the closed position (U.S. Department of Transportation, 1990).

The Strauss design used approximately 2,383 tons of structural steel and has three ground level trunnions (refer to photograph 22), three counterweight trunnions, three lower link bearings, and three upper link bearings on each side (refer to photographs 23-24). The manual controls and railroad status board are located in the control house (refer to photographs 35-39). Two electric motors operate a rack and pinion gear system that powers the individual leaves to start the lift and engage the counterweight balance system (refer to photographs 49-55). The bridge leaves lock together in the center by means of lock motors and hooks to line up the rails for railroad crossings (refer to photographs 25-31). The Los Angeles Harbor Department maintains the bridge structure, superstructure, electrical and mechanical operating systems, navigation lights, and supporting steel girders for the railroad track; it also provides bridge tenders. The Union Pacific Railroad maintains the railroad track structure, including ties and rail above the top of steel track support girders, railroad signals, and the interlocking control cabinet located in the control house (Weinman and Stickel, 1978; Los Angeles Board of Harbor Commissioners, 1924; Los Angeles Harbor Department, 1992; Love, 1925; Union Pacific, 1992).

Modifications and Alterations

During fiscal year 1926-1927, the Ford Bridge counterweights were repaired and steel repainted. One of the railroad tracks was removed prior to World War II. In 1948, as a result of pumping petroleum from underground reserves, there was general subsidence over a 15 square mile area in the eastern section of Terminal Island and adjacent areas of Long Beach, including an eight-foot subsidence adjacent to the Southern California Edison Building. The Ford Bridge and its approaches settled approximately five and one-half feet. The Los Angeles Harbor Department Annual Report for 1948 reported:

> Plans and specifications were prepared covering elevating of steel lift and anchor spans and building up the concrete piers a sufficient height to compensate for the five and one-half foot settlement which had occurred, plus an additional height of two feet to take care of some future settlement. Because of extremely heavy loads involved, it will be necessary to secure steel struts and beams to existing bridge members against which a total of 14 hydraulic jacks, each with a capacity of 350 tons, will bear in raising the bridge. The jacks will be installed at 12 bridge posts, and will be connected to high pressure pumps which will be operated so as to lift the entire bridge simultaneously. As jacking proceeds, steel shims and steel cribbing will be installed to prevent a mishap and to provide a foundation for the jacks in subsequent lifts (Los Angeles Board of Harbor

Commissioners, 1948).
Highway traffic was prohibited during the raising; however, railroad traffic continued, except for a five-day period. In 1952, the bascule bridge required emergency repairs due to damage from a ship collision. The bridge was raised again in 1957, by another seven feet. Since 1957, the oil companies have injected water into the underground strata to stop subsidence.

In 1979, the timber railroad trestles were renovated, and a portion of the roadway trestles restored to provide additional lateral strength and stability to the railroad section. The Los Angeles Harbor Department subsequently strengthened the railroad approach trestles, partially demolishing the deteriorated highway approaches and removing the deteriorating fender system. The bridge was closed to highway traffic in 1978, following the construction of the Schuyler Heim, Vincent Thomas, and Gerald Desmond bridges, which now provide highway service to Terminal Island. Construction to replace the deteriorated timber approach spans with concrete trestles commenced in 1994. The Ford Bridge now generally remains in the open position, its leaves lowered only for train movements to and from Terminal Island.

Present Condition

A full discussion of the Ford Bridge's structural, mechanical, and electrical condition (refer to photographs 1-18) is contained in a two-volume report prepared for the Los Angeles Harbor Department in 1986 by Deleuw, Cather and Company. The report noted the following on the present bridge condition (Los Angeles Harbor Department, 1992):

- The operator and maintenance foreman stated there were no operational problems at that time.
- The operating machinery is in fair mechanical condition with many components out of adjustment. Other machinery is in generally good condition.
- Although there are many deficiencies, the electrical equipment was found to be operable. Much of the conduit and wiring insulation is deteriorated. Several conditions were noted to be substandard according to current codes. The direct phone line to the Commodore Heim Bridge does not function. All closed circuit televisions appear to be in good working order.
- Falling chunks of asphalt pavement from the old asphalt pavement on the bridge is wearing at the surface and could present a danger to operations personnel when the bascule leaves are upright.
- Some localized corrosion of the structure has occurred.
- The bridge is "counterweight heavy." This means that there is an excess of weight on the concrete counterweights as related to the weight of the deck.

This problem creates a condition wherein the circuit breakers sometimes trip during the final stage of closure. The motors must then be started and stopped to ease the bascule leaves into final position. It was reported that this problem occurs primarily on the south bascule leaf. As an interim measure, the Los Angeles Harbor Department has installed approximately ten tons of weight near the ends of each leaf to balance the bridge. Approximately half that weight may be

enough to avoid tripping the circuit breakers.
The physical deficiencies of the bridge are the result of years of corrosion, wear, and aging. The functional inadequacies of the present bridge structure were summarized in the report as follows (Los Angeles Harbor Department, 1992):

- The load capacity (weight limit) of the approach trestle to the bridge is restricted to the equivalent of Cooper's E-32, with loads corresponding to E-51 allowed under permit and operating at speeds not exceeding 10 miles per hour (mph). Most western railroads design bridges to accommodate Cooper's E-80 design loading. The General Manager of the Harbor Belt Line estimates that this load restriction prevents about one heavy rail car load, such as an electrical transformer, from crossing the bridge each year.

- The existing clearances at the Ford Bridge do not conform to the current standards contained in General Order No. 26D of the California Public Utilities Commission.

III. HISTORICAL INFORMATION

Los Angeles Harbor

After the founding of the pueblo of Los Angeles in 1781, sea transport was a relatively unimportant part of the regional economy for nearly 75 years. However, with trade limited by Spanish law to the annual supply ships from San Blas, illegal foreign commerce was carried on by exchange for hides and tallow. At that time, San Pedro Harbor offered ships little more than an anchorage in the lee of Point Fermin. At the roadstead entrance was rocky Dead Man's Island. To the east was a narrow island known as Rattlesnake Island. The shore line on the west was a series of bluffs. Catalina Island to the south southwest and the Palos Verdes peninsula to the west gave some protection to San Pedro Harbor from the weather, but no natural barrier offered a haven against the winter storms from the southwest. Flat lands and tidal lagoons lying directly behind the shoreline had the potential for dredging and tidal scouring. In 1848, Augustus Timms towed two shipwrecked hulls about halfway between Point Fermin and the Inner Basin. Silt and sand deposited around the wreckage enlarged the point of land on which he built a small wharf. Cargoes, mail, and passengers from ships anchored in the roadstead south of Point Fermin were lightered to Timms Point, then carried by coach and horses to Los Angeles (Stimson, 1945).

In 1854, Phineas Banning, a stage-line owner, led a group that bought 2,425 acres of the original Rancho San Pedro land grant awarded to Juan Jose Dominguez in 1784. Mr. Banning established the town of Wilmington at the head of a slough about 4 miles northeast of San Pedro and built a timber wharf. Although the entrances to this inner harbor were shallow and shifting on both sides of Dead Man's Island, Mr. Banning profited by taking lighters through the inner harbor to ocean-going vessels anchored in open San Pedro Bay (Turhollow, 1975).

By 1871, a low rock jetty between Rattlesnake Island and Dead Man's Island had created a current in the channel which was dredged to a depth of 17 feet; by 1881, a 6,700-foot-long breakwater of three types of construction closed the gap (Queenan, 1983).

The first decades of the twentieth century were a period of expansion in the San Pedro Bay area. Los Angeles annexed the cities of San Pedro and Wilmington, joining them to the city by the "shoestring," a strip of land one mile wide and 16 miles long from the southern city limits to the boundaries of the harbor cities. The passage of the Tidelands Act, which transferred most of the tidelands, submerged lands, and other waterfront property to the city to be held in trust, occurred at this time. Port historian, Charles Queenan states that, "the interval between 1920 and 1930 represented the period of greatest advancement in the history of the Port of Los Angeles prior to World War II." Overall, port commerce increased sevenfold in less than a decade. the Los Angeles Harbor Department had 94 lines using its facilities, and paved roads were installed all over the area (Queenan, 1983).

Railroad Expansion

The first rail connection from Los Angeles to the San Pedro and Wilmington area was the Los Angeles and San Pedro Railroad. It was partially financed by bonds issued by the city and county of Los Ańgeles and built by Phineas Banning. In 1869, the railroad began operations to the area. In 1873, the voters of Los Angeles approved an offer by the Southern Pacific Railroad whereby the railroad would receive 60 acres for a station site and all the county's stock in the Los Angeles and San Pedro Railroad in exchange for the construction of 50 miles of track passing through Los Angeles, with a spur line to Santa Ana (Krythe, 1957).

During the 1880's, the Southern Pacific Railroad controlled all of the San Pedro and Wilmington side of the harbor area. In 1888, a small railroad, the Los Angeles Terminal Railroad, was created when a group of St. Louis railroad capitalists acquired Rattlesnake Island. The Los Angeles Terminal Railroad, a consolidation of the Los Angeles & Glendale and Los Angeles & Glendale & Pasadena Railroad, constructed a rail line 27.11 miles in length from Los Angeles to East San Pedro, where it built a wharf. This line opened on November 13, 1891.

In 1892, the Terminal Land Company bought all of Rattlesnake Island and renamed it Terminal Island. Terminal Island was envisioned as the ultimate destination for a railroad from Utah to southern California. However, the Los Angeles Terminal Railroad never built any more track and was bought by the San Pedro, Los Angeles & Salt Lake Railroad with one half interest owned by the Union Pacific (UP) Railroad. The UP subsequently purchased the remaining half interest and the company, then known as the Los Angeles & Salt Lake Railroad, became part of the Union Pacific system (Case, 1927; Gillingham, 1961; Porter, 1949).

The Los Angeles & Salt Lake Railroad constructed a bascule bridge across the entrance to Long Beach Harbor in 1909 from West Ocean Boulevard to Terminal Island. Its span was 180 feet, and its length was 220 feet. This bridge was dismantled in 1934 (Arrowhead, 1910; Long Beach Press Telegram, 1934).

Technological History

The founder of the Strauss Bascule Bridge Company and designer of the Ford Bridge was Joseph Baermann Strauss, whose life work culminated in the 4,000-foot suspension bridge across the Golden Gate in San Francisco Bay. Mr. Strauss was born in Cincinnati, Ohio in 1870. He graduated from the University of Cincinnati and began work in his native city for Ralph Modjeski, a firm which specialized in building bridges. Their designers were interested in the bascule bridge, a modern variant of the medieval drawbridge, which operated on the principle of the seesaw; a single or double-leaf span hinged at the roadway, hoisted and dropped by mechanical counterweights. However, balancing the span required the addition of expensive iron counterweights. Mr. Strauss submitted a design using relatively inexpensive concrete counterweights. Based on the fact that concrete is lighter than iron, he redesigned the bascule mechanism to accommodate more bulk. When his idea was rejected, Mr. Strauss resigned from the firm and formed his own company. A railroad company in Cleveland, soliciting a movable bridge across the Cuyahoga River near Lake Erie, authorized Mr. Strauss' company to build the bridge, providing his company assumed the full cost of the project until its completion. The bridge proved to be a success, which revolutionized the construction of movable bridges. Mr. Strauss designed more than 400 bridges around the world during his lifetime. He died in Los Angeles in 1938 (Southwest Builder and Contractor, 1938).

The Strauss Bascule Bridge Company of Chicago designed nearly all of the bascule bridges built in California before World War II. The success of the design has been attributed to the effectiveness of Mr. Strauss' multiple trunnion scheme; and his establishment of an office in San Francisco from which he could market his product (Mikesell, 1990). His design used cylindrical pins to form a pivotal axis, which had an inherent advantage over single-hinge designs An article ca. 1912 in Southwest Contractor and Manufacturer, by Clancey M. Lewis stated that bridges of the heel trunnion type where the moving leaf is pivoted at the heel of the trusses "demonstrates the adaptability of the bascule to a greater variety of conditions." Mr. Lewis' article also states that "This type was developed for those lengths of span where a through truss (a bridge that carries its traffic load level with the bottom chords) is most economical, and where appearance is considered secondary to economy and efficiency (Lewis, 1912)."

Joseph Strauss' first design for a railroad bridge at the Los Angeles Harbor was a single leaf bascule bridge built over the tidelands of the West Basin in 1911. It carried separate tracks for the Southern Pacific Railroad and the Pacific Electric Interurban Railway. Prior to the bridge's construction, these rail lines reached San Pedro using deep-pile trestles over tidelands. These trestles impeded inner harbor development and developers sought permission from the Federal Government to remove them, accommodating tracks on the new bascule bridge. At 187 feet, it was one of the largest, single-span drawbridges constructed up to that time. The structure was damaged by a veering ship in 1955, then removed in that year as part of a long range plan to open the West Basin to ships (Los Angeles Board of Harbor Commissioners, 1955; Weinman and Stickel, 1978).

Mr. Strauss' second bascule bridge design at the Los Angeles Harbor was the Henry Ford Bridge (Badger Avenue Bridge). The Los Angeles Board of Harbor Commissioners let the contract for the bridge in October, 1922. Work was completed in fiscal year 1923-1924; the cost was $980,000.

Movie History

Since 1950, various movies include scenes shot at the Ford Bridge. The oldest film is "Pacific Western Agent," in 1950. Other known films which include shots of the bridge are "Gary Francis Powers - The U2 Story," "Capricorn One," "The Philadelphia Experiment II," "Terminator II," and "The Rising Sun".

IV. PROJECT INFORMATION

This document has been prepared at the request of the Los Angeles Harbor Department, which is proposing to relocate or demolish the Henry Ford Bridge (Badger venue Bridge) and replace it with a new vertical lift bridge in the same location.

Project Manager for the recordation was Larry Smith, Jr. of the Los Angeles Harbor Department. Jerry Hittleman of P&D Environmental Services was responsible for the written documentation along with Portia Lee, Ph.D., Registered Historian #547, who was the Principal Investigator and prepared the "Cultural Resources Assessment, Henry Ford (Badger Avenue Bridge, Los Angeles Harbor" as a technical appendix to the Henry Ford Bridge (Badger venue Bridge) Supplemental Environmental Impact Report/Environmental Impact Statement (SCH No. 93051014; ADP No. 921027-221). The photographer was Bruce Eckar of Bruce Eckar Photography.

V. BRIDGE OPERATION

The Ford Bridge is normally in the open position to allow maritime traffic in Cerritos Channel unrestricted passage. The bridge is closed for the passage of trains and for periodic maintenance. With the exception of video cameras installed to allow the bridge operator to look for maritime traffic, all controls, motors, and electrical equipment are 1920's vintage. Operation of the Ford Bridge is entirely manual.

The bridge operator (a Los Angeles Harbor Department employee) decides when to close the bridge for rail traffic taking into consideration factors such as current and anticipated maritime traffic, weather conditions, bridge maintenance requirements, and the presence of visitors on the bridge.

Once the decision to close the bridge has been made the operator checks to make sure that all traffic (maritime and pedestrian) has cleared the bridge. The operator sounds the siren then commences to lower the south leaf. This is done by engaging the motors and starting the south leaf down (refer to photographs 2 & 7). As the south leaf is coming down the operator shifts to the north leaf which is then started down (refer to photographs 3 & 8). At this stage the south leaf is almost fully down; the operator shifts his attention back to the south leaf slowing it down and easing it into the fully down position using visual cues on the south leaf to tell him when it is fully down (refer to photograph 34). Once the south leaf is fully down the operator shifts back to the north leaf slowing it down and easing it into the fully down position (refer to photographs 5 & 9) using visual cues on the bridge to tell him when it is fully down (refer to photographs 32 & 33). Power is supplied to both leafs and the bridge is locked down. The operator, who is also a railroad signalman, manually checks all rail connections, then operates railroad signals to allow the train to cross. Interlocks prevent the bridge from being opened while a train is crossing.

Opening the Ford Bridge involves reversing the sequence of events. The bridge is unlocked, south leaf started up first, north leaf started up while the south leaf is moving up, south leaf stopped, north leaf stopped. All references to leaf positioning are visual from within the operator's house. A skilled operator can cycle the bridge in 2-3 minutes.

VI. SOURCES

Arrowhead. Long Beach As It Is Today. September, 1910.

Case, Walter H. History of Long Beach and Vicinity. S.J. Clarke Publishing Company, Chicago, Illinois, 1927.

Gillingham, Robert C. Rancho San Pedro. Dominguez Properties, n.p., 1961

Krythe, Maymie. Port Admiral: Phineas Banning, 1830-1865. California Historical Society, San Francisco, 1957.

Lewis, Clancey M. The Strauss Design of Movable Bridges. Southwest Contractor and Manufacturer. On file, Los Angeles Public Library. 1912.

Long Beach Press Telegram. Bascule Span Nears End Of Use. April 2, 1934.

Los Angeles Board of Harbor Commissioners. Annual Reports of the Harbor Commissioners. Los Angeles Harbor District, Los Angeles, California, 1924-1957.

Los Angeles Harbor Department. Environmental Impact Report for Terminal Island Container Transfer Facility. Los Angeles, California, 1992.

Love, Jay M. Wilmington - The City of Opportunities. Arrowhead. October-November, 1925.

Mikesell, Stephen. Historic Highway Bridges in California. California State Department of Transportation, Sacramento, California, 1990.

Porter, John Sherman (editor). Moody's Manual of Investments: Railroad Securities. Moody's Investor's Service, New York, 1949.

Queenan, Charles F. The Port of Los Angeles: From Wilderness to World Port. Los Angeles Harbor Department, Los Angeles, California, 1983.

Southwest Builder and Contractor. Joseph Strauss, Engineer of Golden Gate Bridge, Dies in Los Angeles. May 20, 1938.

Stimson, Marshall. A Short History of Los Angeles Harbor. Historical Society of Southern California Quarterly, 1945.

Turhollow, Anthony. A Short History of the Los Angeles District: U.S. Army Corps of Engineers 1896-1968. 1975.

Union Pacific Railroad Company. System Timetable No. 9. October, 1992.

U.S. Department of Transportation; United States Coast Guard. Final Environmental Documents for the Rehabilitation of the Ford Avenue Railroad Bridge, in Long Beach, Los Angeles County, California. Alameda, California, 1990.

Weinman, Lois J., and E. Gary Stickel. Los Angeles-Long Beach Harbor Areas Cultural Resource Survey. Submitted to U.S. Army Engineer District. Los Angeles, California, 1978.